Sector	Subsector	Potential Effects to Resources, Operations, and People
ATMO	Greenhouse gases	Increased carbon storage where forests spread; decreased where drought causes loss of forest or where fire and permafrost release methane and CO_2. Shrub expansion into deglaciated areas and new vegetation = carbon sequestration
	Air temperature	Air temperature increases ~1°F per decade; greatest change in the north and in winter. Average annual temps shift from below freezing to above freezing, changing freeze/thaw balance.
	Precipitation	Average annual precipitation increases. Relative amounts of snow, ice or rain change. Many areas experience drying conditions despite increased precipitation. More freezing rain events affect foraging success for wildlife, travel safety, etc. Avalanche hazards increase with rising precipitation and rising winter temps.
	Storms	Lightning and lightning-ignited fires continue to increase. Storm and wave impacts increase in northern Alaska where land-fast sea ice forms later.
	Air quality	More smoke from longer and more intense fire seasons.
	Contaminants	Increased contaminants and shifting contaminant distribution.
CRY	Snow/ice	Later onset of freeze-up and snowfall + earlier spring snowmelt and break-up. Arctic snow cover declines with higher air temperatures and earlier spring thaw. Lack of snow cover leads to deeper freezing of water in the ground or rivers. Cultural resources are exposed as snow and ice patches melt and recede.
	Glaciers	Most glaciers diminish as warming continues, though a few are still advancing. Glacial outwash affects aquatic productivity and forms deposits in shallow water. Glacial lakes fail more frequently, creating risk of flash floods and debris flows. Surging glaciers could block rivers and fjords, resulting in severe flooding.
	Sea ice	Less sea ice complicates travel, impacts ecosystems, and adds energy to storm surges. Seasonal reductions in sea ice increase the risk of spills contaminating coastal resources.
	Ice roads	Reduced winter transportation affects opportunities for travel and subsistence.
	Permafrost	Mercury & other pollutants are released into aquatic environments as permafrost thaws.
HYD	Sea level	Global average sea level is predicted to rise 1-6 feet by the end of the 21^{st} Century. Increased storm surges and permafrost erosion compound effects of change in sea level. Some coastal villages rapidly lose ground from storms, erosion and subsidence.
	Marine	Increasing sea surface temperature affects fish, seabird, and wildlife populations. Falling global phytoplankton could reduce ocean productivity and CO_2 sequestration. Freshwater influx from thawing glaciers dilutes marine waters, stressing animals. Toxic marine algae & shellfish poisoning attributed to changes in water conditions. Ocean acidification affects food sources of fish, marine mammals and birds in the Arctic. Ocean acidification reduces sound absorption (by 40% by mid-century?)
	Estuarine	Coastal erosion and sea level rise increase the frequency of saltwater flooding. Some shallow water areas convert to terrestrial ecosystems with post-glacial rebound.
	Freshwater	Stream flows from melting glaciers increase and then decrease over time. Ponds shrink as ground ice thaws or thermokarst drainage occurs in permafrost areas. Drainage from thawing waste and sewage dumps contaminates rural water supplies.
	Groundwater	Groundwater supplies dependent on seasonal glacial recharge become less predictable.
LITH	Ground level	Ground level rises in recently de-glaciated areas because of isostatic rebound.
	Ground stability	More roads and infrastructure fail or require repairs due to permafrost thaw. Landslides and mud flows increase on steep slopes. Rapid glacial retreat and permafrost thaw leave steep and unstable slopes in valleys and fjords. Earthquake activity increases in recently deglaciated areas due to isostatic rebound. Large and small tsunamis could result from collapse of unstable slopes in fjords.

Sector	Subsector	Potential Effects to Resources, Operations, and People
		Coastal erosion claims both natural and cultural resources and constructed assets.
		Burials and other remains are exposed as cultural sites thaw and erode.
	Soil	Soil moisture declines due to rising soil temperature, thawing permafrost, and drainage.

BIOS PHE RE	General	Ecological "tipping points" are likely to result in rapid change, when conditions exceed physical or physiological thresholds (e.g., thaw, drought, water temperature)
	Vegetation	Average number of frost-free days for the Arctic could increase 20-40 days by 2100.
		Increased agricultural production in Alaska because of longer growing season.
		Potential large-scale shift of tundra to shrubs, to conifers, to deciduous forests or grass.
		Atypical outbreaks of pests and diseases affect native species and increase fire hazards.
		Invasive exotic plant species and native species from other areas expand their ranges.
		Vegetation expands into deglaciated coastal areas, less into higher elevation areas.
		Tree species and vegetation classes shift as species of lower latitudes and altitudes expand.
	Forests	Black spruce may expand with warming – or contract as permafrost soils thaw and fires increase.
		Mature forests and “old growth” decline because of drought, insects, disease, and fire.
		Mature yellow cedars decline across southeast Alaska, possibly due to lack of insulating snow.
	Fire	Models show a warmer climate leads to larger, more frequent and intense fires.
		Wildland fire hazards increase, affecting communities and isolated property owners.
		Fire-related landcover and soil changes result in vegetation shifts, permafrost thaw, etc.
BIOS PHE RE	Wildlife	Changes to terrestrial and aquatic species occur as ranges shift, contract, or expand, affecting visitor experience and subsistence throughout the parks.
		Parks and refuges may not be able to protect current species within their boundaries.
		Animals and plants will expand into landscapes vacated by glacial ice.
		Some species will suffer severe loses. So far, the greatest losses across all parks have been rodents, bats, and carnivores.
		Predator-prey relationships may change in unexpected ways.
		Migratory routes and destinations will change (e.g., wetlands, open tundra, snow patches).
	Birds	Arctic and alpine birds’ breeding habitats reduced as trees and shrubs encroach on tundra.
		Kittlitz's murrelet populations decline with loss of important nesting and foraging habitat.
		Waterfowl shifts occur as coastal ponds become more salty.
		Productivity of nesting shorebirds may increase if schedules change to coincide w/ insects.
		Predation on ground nesting birds could increase if prey (lemming) abundance declines.
		Coastal seabirds (e.g. Ivory Gull and Aleutian Tern) are vulnerable to climate change.
		Population cycles of birds and their prey could be out of sync due to higher temperatures.
	Marine Mammals	Arctic marine mammals (e.g. seals, walrus and whales) are affected by sea ice decline.
		Less sound absorption (ocean acidification) affects marine mammals that rely on echolocation.
		Polar bears may have increasing difficulty accessing prey and finding shelter.
BI O S	Caribou/Reindeer	Caribou and reindeer health are affected by changes in weather, forage, and insects and pests.
		Earlier green-up could improve caribou calf survival because of more available forage.
		Caribou may suffer heavy losses if rain events prevent successful feeding during cold weather.
	Moose	Shifts in forests could mean less habitat for caribou, but more habitat for moose.
		Climate change could hinder moose calf birth success and moose calf survival.
	Small Mammals	Fire may create new burrowing habitat and forage growth to help vole populations.
		Less snow cover reduces survival of subnivian species, due to increased predation & cold stress.
	Fisheries	Commercial fisheries are affected by changes to ocean communities in the Bering Sea.
		Some marine plant and animal populations may decline with ocean acidification.

Sector	Subsector	Potential Effects to Resources, Operations, and People
		New stream habitats become available for fish and wildlife as glaciers decline.
		Some salmon waters may become unsuitable for migration, spawning and incubation.
		Fish diseases increase with rising stream temperatures.
		Fish habitats in permafrost areas are degraded by slumps and sediment input into rivers.
	Invertebrates	Ice worm populations decline locally as glacier habitats melt.
		Marine intertidal environments change, may become more susceptible to exotic marine species.
		Exotic pests expand from warmer areas, and endemic pests expand as host species are stressed.
	Subsistence	Altered animal migration patterns make subsistence hunting more challenging.
		Sea ice changes make hunting for marine mammals less predictable & more dangerous.
		Managing new species and intensified management of native species may be needed.

Sector	Subsector	Potential Effects to Resources, Operations, and People
OTHER	Tourism	Longer summer seasons could increase tourism. Some visitor activities increase, while others (e.g., snow sports) may decline. Landscape-level changes affect visitor experiences and access, visitor use patterns shift.
	Wilderness	Large-scale physical and biological changes across broad landscapes affect abundance and condition of wilderness-associated resources (e.g., glaciers, wildlife, access routes, etc.) Changing biophysical landscape affect key wilderness values such as naturalness, wild-untamed areas wtihout permanent opportunities for solitude, etc.
	TEK	Uses of traditional ecological knowledge become less predictive and less reliable.
	Devpmt	More natural resource development in Alaska with increasing global demand. Fuel and energy prices increase substantially with carbon mitigation measures. Costs of transporting fuels to remote locations becomes more challenging and costly.